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CRAYFISH AS VECTORS OF TRANSFER AND BIOCONCENTRATION OF MERCURY

Mercury (Hg) pollution is a major concern, especially in lakes and streams remote from Hg point sources. Mercury present in remote lakes can be a threat to wildlife feeding on fish and other contaminated biota in addition to humans. Many pristine lakes and streams in Ontario contain predatory fish with Hg levels exceeding the Canadian 0.5 ug/g wet weight upper limit for safe consumption.

Fish accumulate Hg from water as it passes over the gills and from ingested food. Although the top predators such as bass can integrate mercury from food and water, these organisms tell us very little about the pathways of Hg to these fish. Practically all (> 95%) of total Hg in fish muscle tissue is in the organic form, namely methylmercury (CH_3Hg). The ability of CH_3Hg to bioaccumulate to higher concentrations in biota relative to the metallic (inorganic) form of Hg is related to: 1) the excretion rate - CH_3Hg is excreted more slowly than the inorganic form, and 2) a more efficient assimilation from food and water.

We have been evaluating the use of crayfish as a biomonitor of Hg contamination because other studies have shown that these animals transfer CH_3Hg from sediment to fish and wildlife. These crustaceans comprise a significant proportion of the biomass of the organisms found on the bottom of lakes and streams. Their role in Hg transfer may be important because of the close contact of crayfish with the sediments, the principal "sink" for mercury. Restricted movement of crayfish relative to fish also provides a better opportunity to detect potential local Hg sources. Crayfish also belong to several trophic levels and consume a wide variety of food types, such as algae, detritus, vegetation, benthic invertebrates and fish remains. In turn, crayfish are an important food source for a number of fish species, fish-eating birds and mammals such as mink, otter, and raccoon.

Questions that we have been addressing include the following: 1) What is the appropriate tissue (e.g., muscle, gut, exoskeleton, etc.) to analyze for Hg? 2) Does Hg concentrations differ in crayfish between lakes and streams? If so, by how much? 3) Do individuals of different sexes show similar patterns of Hg bioaccumulation and contamination? and 4) How efficient are crayfish in converting Hg from food into body tissues and how long does this Hg remain in the crayfish?

We have studied a single crayfish species *Orconectes virilis* because it is commonly found in lakes and streams in south-central Ontario. Furthermore, it is the most widely distributed crayfish species in Canada and is thought to live for about 4 years. The results from *O. virilis* should apply to the other 5-6 crayfish species commonly found in Ontario.

FIELD STUDIES

Mercury analyses show that concentrations of Hg are higher in green glands, abdominal and claw muscles than other tissues (e.g., eyes, gills, digestive glands, exoskeleton and mid and hind guts, etc.) (Fig 1). Crayfish could therefore be sampled without being killed by removing a claw which the animal is capable of regenerating.

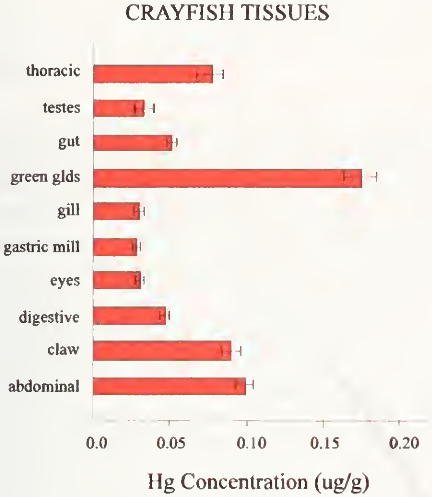

CRAYFISH TISSUES

Figure 1. Mean mercury concentrations (+/- S.E.) in various crayfish tissues (n=5-10).

Concentrations of total Hg in abdominal muscles were significantly different in different lakes and streams. These differences were strongly correlated with water chemistry parameters such as hydrogen ions, aluminum, iron, dissolved organic carbon (DOC) and Hg concentrations in lake and stream water. The relationship (Fig.2) of higher total Hg concentration in crayfish abdominal muscle with higher DOC (humic substances) is similar to the results found for many fish species in Ontario(STB Tech. Bull. AqSS-6)

Concentrations of total Hg in abdominal tissue of crayfish from different lakes ranged from 0.035 to 0.719 ug/g, with some organisms showing higher than the 0.5 ug/g standard for safe consumption of fish by humans(Fig. 3).

Methylmercury (CH_3Hg) in the abdominal muscle represented >95% of the total mercury measured, which is similar to those values reported for fish and zooplankton. Therefore, measurement of total Hg is adequate for estimating Hg contamination in biota.

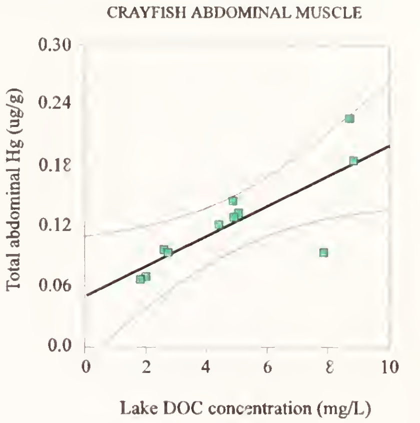

CRAYFISH ABDOMINAL MUSCLE

Figure 2. Correlation of total Hg in crayfish abdominal muscle to Lake DOC shown with 95% confidence intervals

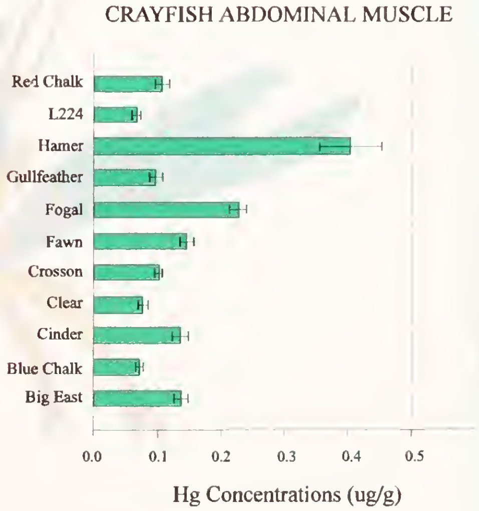
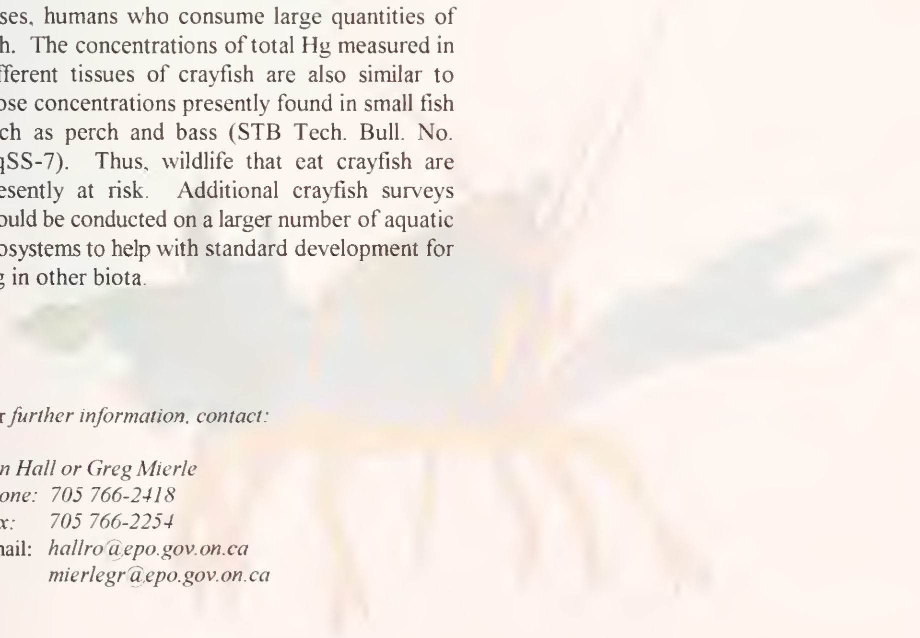

CRAYFISH ABDOMINAL MUSCLE

Figure 3. Mean crayfish abdominal tissue concentrations (+/- S.E.) between lakes. Vertical line shows provincial guideline.

LABORATORY STUDIES

Additional studies were conducted in the laboratory. Here crayfish of different sizes and sexes were fed CH_3Hg contaminated food. These results showed that all crayfish were very efficient (96%) in converting this organic Hg into their body tissues, particularly abdominal muscle, in less than one week. The rate of CH_3Hg uptake was the same for all sizes (or ages) and both sexes of crayfish. Final CH_3Hg concentrations in the tissues depended upon the amount and concentration consumed.

In addition, most of the CH_3Hg bioaccumulated in the tissues was not lost by excretion and moulting during the predicted 2-4 year life cycle of these organisms. Therefore, these organisms are important indicators and biomonitors of both point source and non-point sources of Hg contamination in lakes and streams. Also, these crayfish are important vectors of transfer as a food source to fish, bird and mammal predators, and, in some cases, humans who consume large quantities of fish. The concentrations of total Hg measured in different tissues of crayfish are also similar to those concentrations presently found in small fish such as perch and bass (STB Tech. Bull. No. AqSS-7). Thus, wildlife that eat crayfish are presently at risk. Additional crayfish surveys should be conducted on a larger number of aquatic ecosystems to help with standard development for Hg in other biota.



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